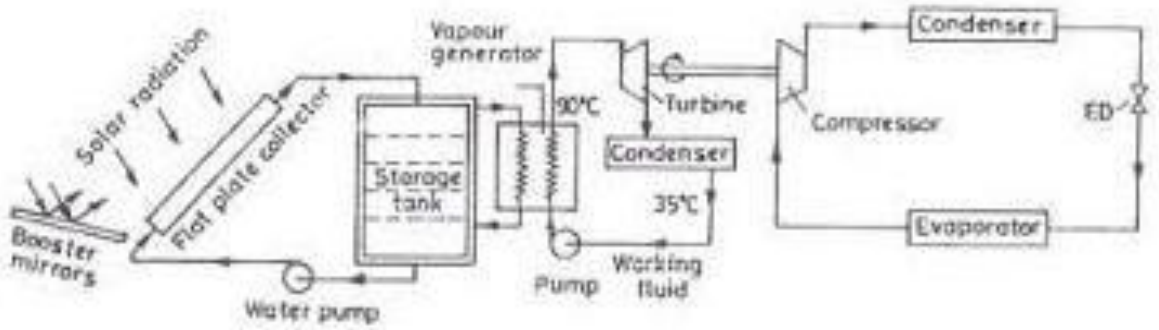
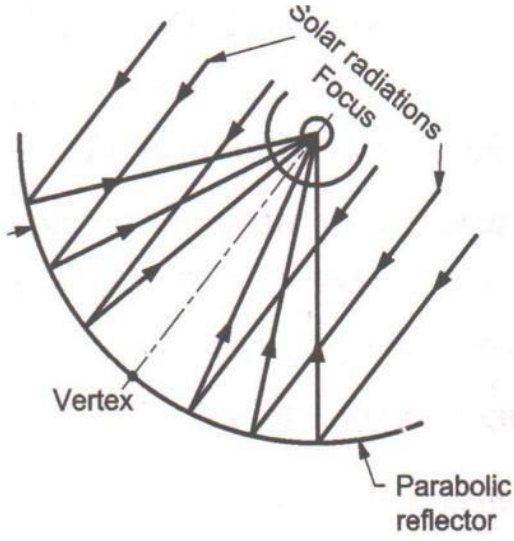
WINTER – 19 EXAMINATION

Subject Name: RESM **Model Answer** Subject Code: 17611

Important Instructions to examiners:

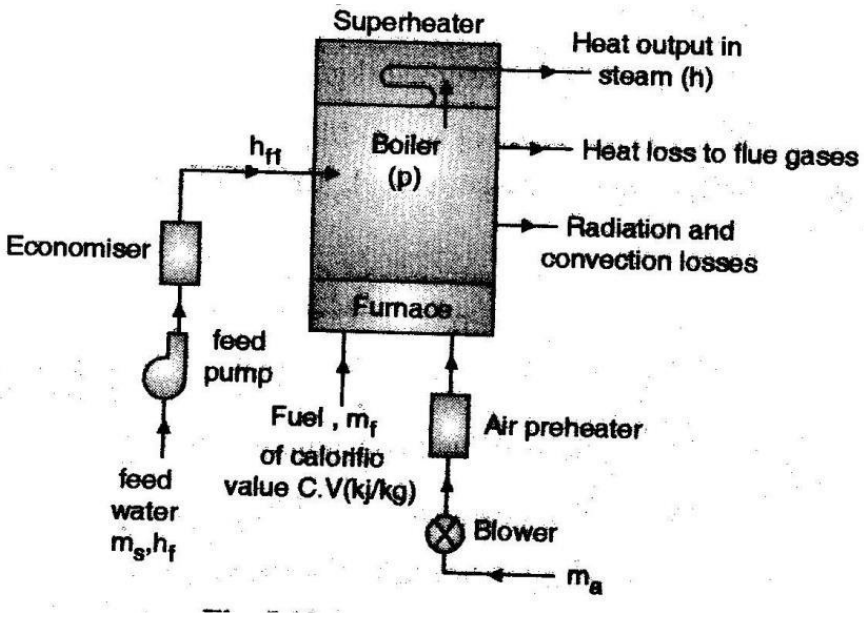
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answer	Marking Scheme
Q.1 (a)	i)	Different types of Renewable energy sources are : 1) Solar energy 2) Wind energy 3) Tidal energy 4) Geothermal energy 5) Bio mass energy Utilization of energy sources can be by direct and indirect methods Direct methods – Thermal and photovoltaic Indirect methods – Tidal, wind, biomass and ocean thermal energy	**2M** **2M**
	ii)	A Solar vapor compression refrigeration system is shown in figure.  	**4M**

	iii)	**Solar concentrating collector:-** These concentrating collectors are used in which the absorber is placed along the focus axis. In this the collector pipe is used as an absorber with a selective coating. Parabolic reflectors are usually made of highly polished or silvered glass or of a film of aluminized plastic on affirm base. Instead of the reflector having a continuous form the reflector may be made of a large number of flat mirror strips on the parabolic firm base.  **Parabolic concentrating solar collector**	**2M** **2M**
	iv)	Parameters considered during site selection : 1) Availability of land 2) Connectivity to grid 3) Connectivity to the road 4) Easy access to locality/infrastructure 5) Ecology 6) Cost of transmission of energy 7) Cost of land and taxes 8) Transportation facilities	**Any four Points 1M each**
Q.1 (b)	i)	**Uses of Instruments:-** a. **Lux meter**: To measure illumination level b. **Pyranometer** : To measure global radiations c. **Pitot tube** : It is a flow measurement device used to measure fluid flow velocity. d. **Fyrite :** To make reference measurements for calibrating sensors in laboratory e. **Infrared thermometer** :- To measure temperature of heat source without coming in contact with other surface f. **Fuel efficiency monitor** :-	**1M EACH**

		1. In this instrument the calorific value of the commonly used fuels are fed into microprocessor. 2. When this instrument measures the oxygen and temperature of the flue gas, it automatically calculates the efficiency of the combustion	
	ii)	**Need of orientation in concentrating type collectors**: In flat plate collectors solar direct and diffuse radiations without sun tracking are collected for heating. It causes the loss of energy during sunshine period since the solar radiations will not be normal to the surface and the temperature achieved are only 100 ^{0}C . For temperatures above these concentrating type collectors are needed. A cylindrical parabolic collector is oriented with its focal axis pointed either in the east-west or the north-south direction. In the east-west orientation the focal axis is horizontal while in the north-south orientation, the focal axis may be horizontal or inclined. Different methods for sun tracking : i. The focal axis is east-west and horizontal ii. The focal axis is north-south and horizontal iii. The focal axis is north-south and inclined at a fixed angle equal to the latitude.	2M 2M
Q.2	a)	1) **Altitude angle (α):** It is defined as the angle between the central ray from the sun , and a horizontal plane containing the observer is the Solar altitude angle. At the Sunrise and Sunset the solar altitude angle(α) is zero. 2) **Zenith Angle** : If a vertical line is drawn to the horizontal plane at its centre the line joining sun and the centre of the plane will make an angle ɵ with this vertical . This angle is called the Zenith angle. 3) **Day length (td):** It is the time elapsed between sunrises to sunset. By knowing the values of sunrise and sunset hour angle, we can calculate the day length. 4) **Solar Azimuth angle** ( ):- It is the horizontal angle measured on plane from north to the projection of suns rays on this plane . 5) **Local solar time** :-This is also called as Local Apparent Time (td) and can be calculated using various values of zenith angle . the time so calculated is called the Local Solar Time. 6) **Surface azimuth angle** :- ( ) : It is defined as the horizontal angle between the projection of the normal to the horizontal surface and the north south line. 7) **Slope** : It is also called as tilt angle ( ) . The vertical angle between one edge of a surface and its projection on the horizontal plane is called the tilt angle . 8) **Declination angle (δ)** : It is the angle between a line extending from the centre of the sun to the centre of the earth and the projection of this line upon the earth's equatorial plane.	**1M each**
b)	i)	Energy plantation: There are certain plants which can be planted and harvested over regular period of time to have high yield per unit area. Thus the method of tapping maximum solar energy be growing plants on large scale is called energy plantation. Main plants proposed for energy plantation: Following plants are suitable for large scale plantation in Indian conditions having high yield a) Casuarina : These are suitable for plantation in coastal areas b) Eucalyptus : These are very fast growing trees. It grows to about 15m in three years c) Sorghums : These energy crop is suitable for alcohol production	**2M**

		d) Other suitable trees : These are babool, Leucaena, Jajoba etc Advantages of energy plantation: 1. Emit little or no sulphur and less nitrogen dioxide than fossil fuel. 2. Helps in rehabilitation of degraded lands. 3. Provide rural employment. 3. Alive and active growing forest and other plant biomass absorb the green house gas in quantities broadly equivalent to amount emitted when plant material decay or burned.	**2M**
	ii)	**Dry fermentation** : 1.Organic input remains stationary throughout process, eliminating moving parts and resulting in low system maintenance and repair costs 2. Batch process and stationary system allow precise control over input removal ensuring maximum energy yield Closed loop liquid cycle following start-up, eliminating post-process waste water treatment needs 3. No pre-treatment or sorting of inputs required prior to system loading, saving time and money for system operators 4. Almost no limitations to inputs—over 3,000 inputs have been identified and researched BIOFerm system has low energy consumption, using only 5% of the energy generated for plant operation **Wet fermentation** 1. System requires mechanical parts to circulate biomass in liquid holding tank, leading to increased maintenance and repair costs 2. Liquid mixture causes premature removal of input before all organic matter has been digested, resulting in a loss of energy 3. System requires additional liquid to allow fermentation, greatly increasing the amount of system waste water and costly post-process treatments 4. Inputs require pre-treatment to prevent breakdown of mechanical parts as input is agitated and moved through system Input limited to “wet” waste streams .	**2M each**
c)	i)	**Energy Conservation**: It means reduction in energy consumption without making any sacrifice of quality and quantity of production or same energy consumption getting higher production .It may be achieved through efficient energy use .it may result in increase of financial capital, security and human comfort. **Means of improving boiler efficiency:** Some of the ways to improve boiler efficiency are related to combustion process, to reduce the heat losses, reduction in power consumption. 1. Control of Temperature of exhaust gases at entry to chimney and utilization of flue gases a) Air preheater b) Feed water heating in the	**2M**

		economizer 2. Control of excess air to ensure complete combustion of fuel 3. Reduction in radiation and convention heat losses 4. Control of steam pressure in boiler 5. Preheating combustion air 6. Reducing blow down 7. Stopping dynamic operation 8. Switching to lower cost fuel	**2M**
	ii)	**Energy Audit:** An energy Audit is the first step in energy management programme. It shows how efficiently energy is being used and highlights opportunities for energy cost savings. It also shows ways to improve productivity.  **Figure shows energy audit in boilers**	**2M** **2M**
Q.3	a)	**Global Warming**: It is also called as climate change. It refers to the long term fluctuations in temperature, precipitation, wind and earth elements of the earth climate system. The effects of global warming have taken its role on people, animals, birds and habitat. In fact no continent has been spared. Developing countries are twice as at risk to climate change as industrialized countries, and small islands states are thrice as at risk Estimates drawn from reports by the Intergovernmental Panel on Climate Changes (IPCC) projects increase in average global temperatures ranging from 1.4 ^{0}C to 5.8 ^{0}C	**4M**

b) **Differentiate between biomass and biogas** — **01 M for each**

Sr. No	Biomass	Biogas
1	It is biological material derived for living organisms	It is a mixture of gases produced from organic matter
2	It is in the solid state	It is in the gaseous state
3	Sources are living organisms and organisms died recently	Sources are organic matter
4	Composed of biological material	Composed of methane and carbon di oxide

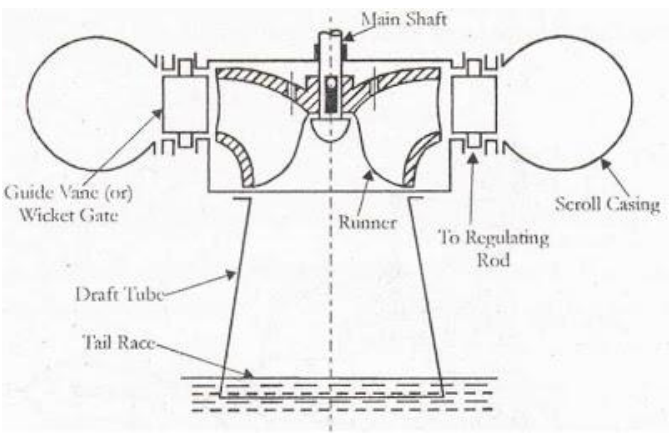
c) **Francis turbine** — **2M**

In Francis Turbine water flow is radial into the turbine and exits the Turbine axially. Water pressure decreases as it passes through the turbine imparting reaction on the turbine blades making the turbine rotate.

Francis Turbine has a circular plate fixed to the rotating shaft perpendicular to its surface and passing through its center. This circular plate has curved channels on it; the plate with channels is collectively called as runner. The runner is encircled by a ring of stationary channels called as guide vanes. Guide vanes are housed in a spiral casing called as volute. The exit of the Francis turbine is at the center of the runner plate. There is a draft tube attached to the central exit of the runner.

Francis Turbines are generally installed with their axis vertical. Water with high head (pressure) enters the turbine through the spiral casing surrounding the guide vanes. The water looses a part of its pressure in the volute (spiral casing) to maintain its speed. Then water passes through guide vanes where it is directed to strike the blades on the runner at optimum angles. As the water flows through the runner its pressure and angular momentum reduces. This reduction imparts reaction on the runner and power is transferred to the turbine shaft.

2M

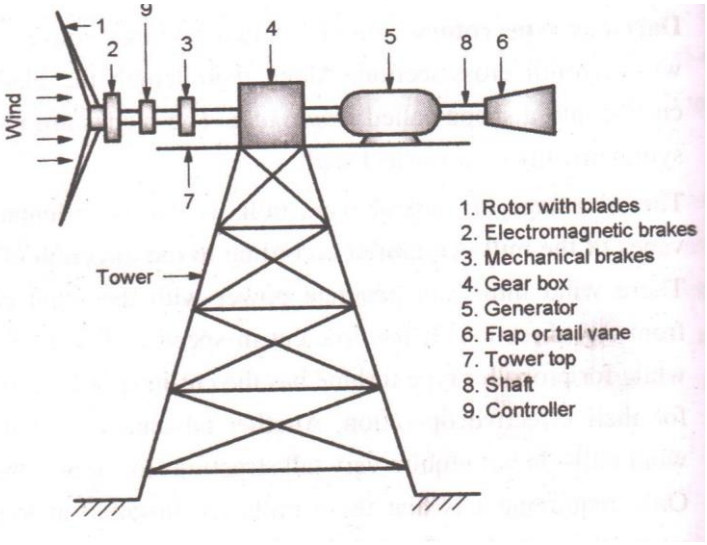


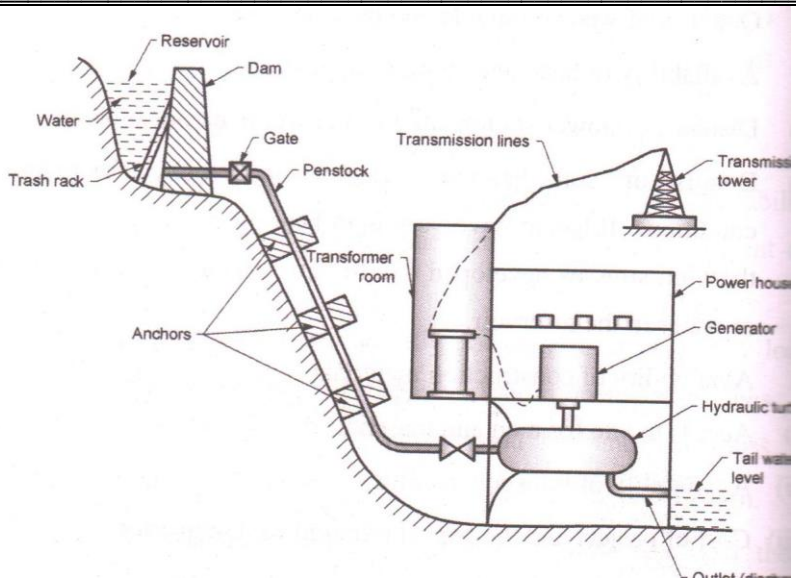
	d)	**Photosynthesis** : It is the process in which solar energy is converted into biomass energy. Photosynthesis process occurs only in green plants. It is the process of combining CO2 from the atmosphere with water in the presence of light energy to produce carbohydrates and oxygen. The photosynthesis process is complex but overall photosynthesis process can be represented by the following process $6CO_2 + 6H_2O + \text{light energy} = C_6H_{12}O_6 + 6O_2$ Total energy stored in the photosynthesis process is about 4500 Kj Conditions for Photosynthesis:- 1 Chlorophyll must be present in leaf cells for photosynthesis to occur. 2 Leaves must be exposed to light for photosynthesis to occur. 3 Plants need carbon dioxide to be able to photosynthesis.	**4 M**
	e)	**Distinction between concentrating and non concentrating solar collector**	**1 M for each**

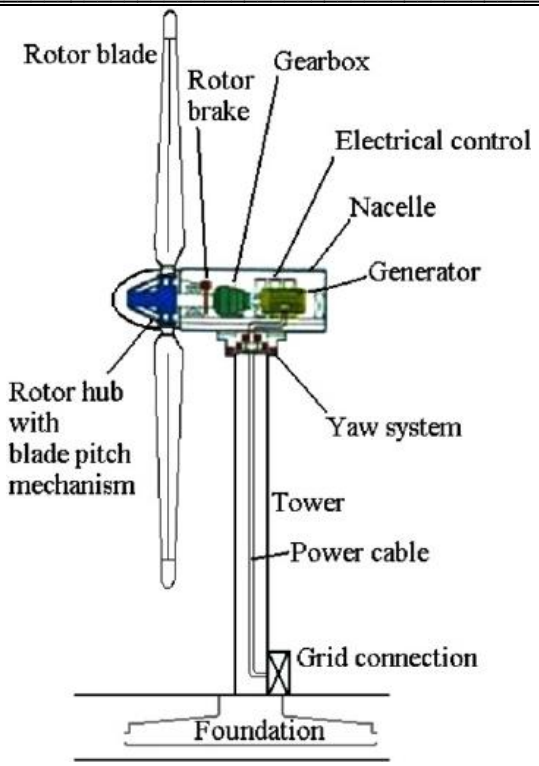
Sr. No	Non concentrating or Flat plate collectors	Concentrating type collectors
1	Absorber area is large.	Absorber area is small.
2	Concentration ratio is 1.	Concentration ratio is high.
3	It is uses both beam and diffuse radiation.	It is uses mainly beam radiation.
4	Application limited to low temperature uses suitable for all places as it can work in clear and cloudy days.	High temperature application such as power generation suitable where there are more clear days in a year.

	f)	**Detailed Energy Audit Methodology**: It is a comprehensive analysis of an energy project and offers the accurate estimate of energy savings and cost. It covers the detailed study of present energy consumption, the use of energy for various processes with calculations of energy efficiency and to evaluate the improvements which can be carried out in its energy use. Detailed audit finally recommends the energy conservation proposals with cost of investment needed. It also presents the detailed study of expected savings in energy cost. The detailed energy audit report consists of the following : 1. Details about plant 2. Description of production processes involved 3. Description of energy and utility system	**4M**

		4. Detailed process flow diagram and energy 5. Calculation of energy efficiency and process systems 6. Recommendations for energy conservation	
Q.4 (a)	i)	1) **Pyrolysis:** It is the heating of biomass in a closed vessel at temperatures in the range of 500 0C to 900 0C in absence of O2/ air or with steam. It produces solid, liquid and gases. This process can use all type of organic materials including plastic and rubbers. 2)**Fermentation** : it is a process of decomposition of complex molecules of organic compound under the influence of microorganism (ferment) such as yeast, bacteria, enzymes etc. The example of fermentation process is the conversion of grains and sugar into ethanol and CO2 in presence of yeast.	**2M** **2M**
	ii)	**Principles of photovoltaic power generation**: Photovoltaic plants consist of photovoltaic cells which work based on the photovoltaic effect. In photovoltaic effect, two dissimilar materials (like silicon and germanium) are put in close contact. When exposed to radiation, electrons from one material absorb the photons, get excited and jump to the other material. This movement of electrons induces positive charge in one material and negative in the other resulting in generation of electro motive force. In a solar power plant, an array of solar cells in created (in series and parallel with each other) to produce desired current and voltage level **Components of SPV system:** 1. PV array 2. Inverter 3. Storage batteries 4. Charge controller of battery controller 5. Equipment to control, conduct and protect power	**2M** **2M**
	iii)	**Advantages of renewable Energy sources** 1. These energy sources are sustainable and will never exhaust 2. It is available in abundance. 3. It has low operating and maintenance cost. 4. No fossil fuels are needed. No elaborated arrangements are required for transportation, handling and storage of fuels as needed in conventional power plants. 5. It can directly be converted into electrical energy using photovoltaic cells. 6. These energy sources produce no waste products, so it has no impact on environment. It is pollution free.	**1 M each** **any four**

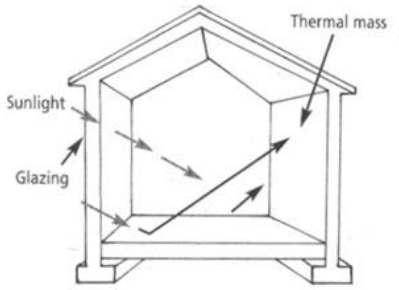
	iv)	**Basic components of wind mill**  	**4M**
b)	i)	**Waste heat Recovery system** Waste heat is energy that is rejected to the environment. It arises from equipment and operating inefficiencies, as well as from thermodynamic limitations on equipment and processes. Often, part of waste heat could potentially be used for some useful purpose. At present, about 20 to 50% of energy used in industry is rejected as waste heat . A significant part of this wasted energy is low-temperature heat that is sent to the atmosphere mainly from cooling water, fin-fan coolers and flue gases. Usually, distillation column overhead streams at temperatures of 100–200 0C reject heat by fin-fan coolers, and streams at a temperature less than 100 0C reject heat to the cooling water system. WHR can be defined as the process of capturing some portion of the heat that normally would be wasted, and delivering it to a device or process where it can be used as an effective, economical and environmentally friendly way to save energy. Large investments are presently incurred to exhaust waste heat to the atmosphere in the form of cooling towers, fin-fan coolers and very tall stacks for the disposal of flue gases. WHR has the potential to minimize these costs, and to reduce environmental impact along with several other benefits.	**6M**
	ii)	**Hydro electric plant** : In Hydro electric power plants the energy of water is utilized to move the hydraulic turbines which in turn runs an electric generator to convert the mechanical energy of turbine into electric energy. The rain water that flows on the earth's surface has potential energy relative to the ocean towards which it flows. In hydro electric power plants, the water is collected and artificially stored by constructing dams across the flowing stream. This potential energy of water is converted into mechanical work and ultimately into electrical energy.	**3M**

			**3M**
Q.5	a)	**Classification of wind turbine**: a) **According to their axis of rotation** 1) Horizontal axis wind turbine 2) Vertical axis wind turbine b) **According to size of capacity** 1) Micro size 2) Small size 3) Medium size 4) Large size c) **According to applications** 1) interconnection with utility grid 2) connected to power backup 3) pumping windmill 4) grain grinding windmill d) **Based on type of rotor** 1) Propeler type 2) Multiple blade type 3) Savonius type 4) Darrieus type	**2M**



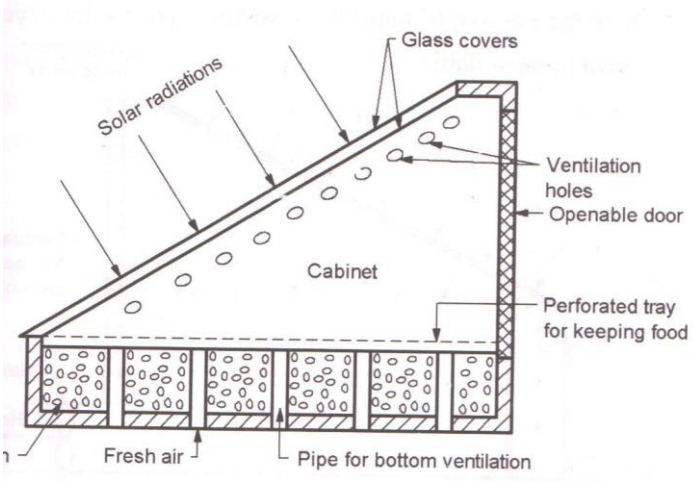
2M

b) **1. Solar Space heating:**

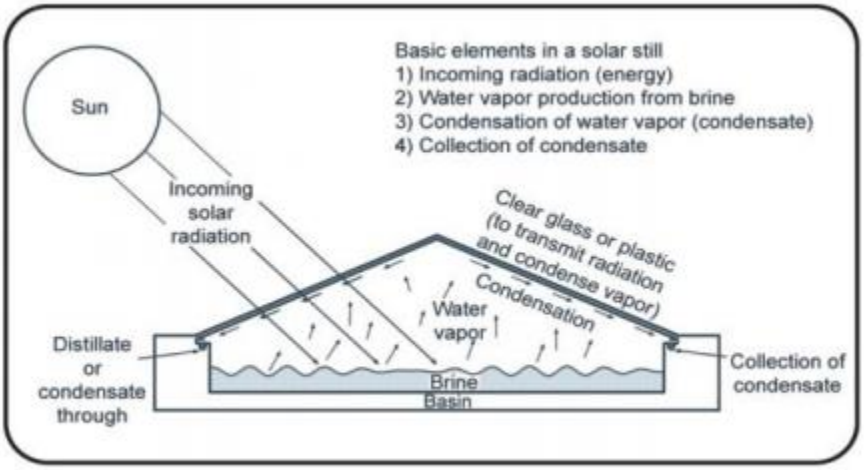


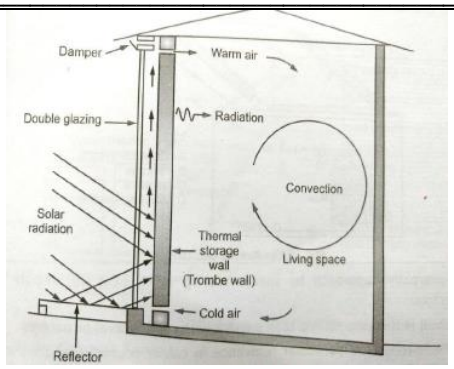
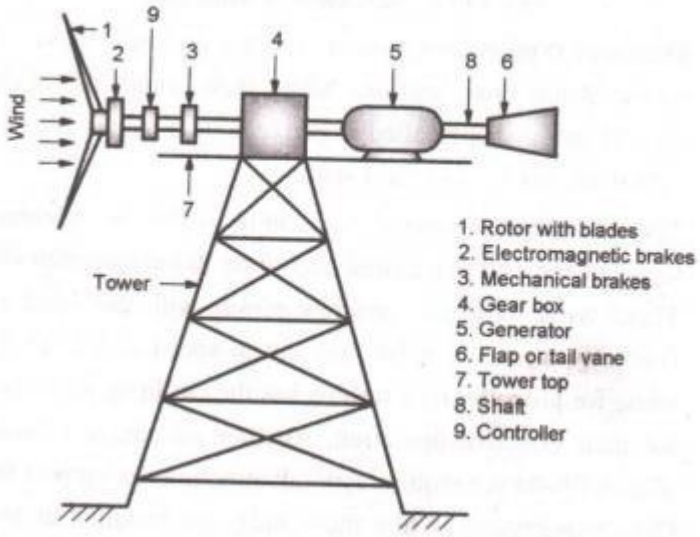
2M

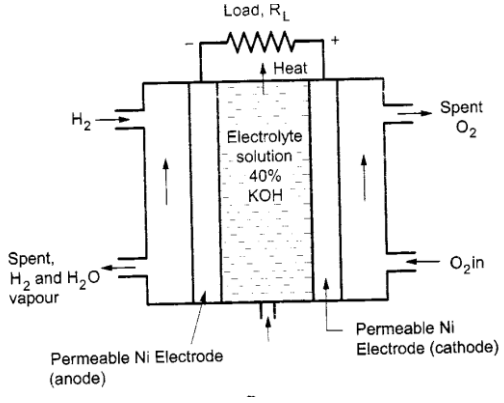
2. Solar food dryer:



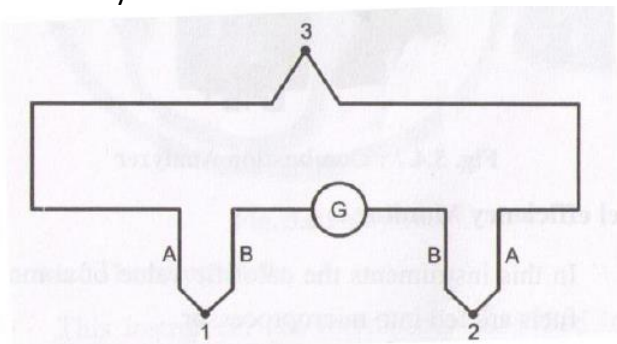
2M

	c)	**Explain solar distillation process.**  Fig- **Solar distillation** Figure shows various components of conventional double slope type solar distillation system. It is a air tight basin usually made up of concrete or special fiber with a transparent cover to accept radiation from the sun. The inner surface of solar still is blackened to absorb maximum solar radiation. The blackened surface is known as basin liner. The saline water is taken into basin for purification. The depth of the water is around 5 to 10 cms. Solar radiations after going through the still kept absorb by the blackened surface of the basin and thus temperature of water increases. Evaporated water increases the percentage of moisture which later on gets condensed on the cooler underside of the glass and then it is collected by means of condensate channel. in this way with the use of solar energy distillation process is completed.	**2M** **2M**
	d)	**Passive solar heating system** : A solar space heating can consist of a passive system, an active system or combination of both. Passive systems are typically less costly and less complex than active system. Passive solar space heating takes advantage of warmth from the sun through design features such as large south facing windows and materials in the floors or walls that absorb warmth during the day. A sunspace or greenhouse is a good example of passive system for solar space heating The south facing thick wall called trombe wall is made of concrete, adobe, stone or composite of bricks, blocks and sand designed for thermal storage. in order to increase the absorption the outer surface is painted black. The entire south wall is covered by one or two sheets of glass or plastic sheet with some air gap between the wall and inner glazing. Solar radiation after penetration through the glazing is absorbed by the thermal storage wall. The air in the air gap glazing and the wall thus gets heated, rises up and enters the room through the upper vent while cool air from the room replaces it from the bottom went. The circulation of air continues till the wall goes on heating. Thus wall collect, stores and transfers the heat to the room. Heating can be adjusted by controlling the airflow through the inlet and outlet vents by shutters. With help of damper at the top of glazing allows the excess heat to outside when heating is not required	**2M**

			**2M**
	e)	**Working of wind energy system with main components** Basic structure of windmill consists of the following components. I) **Rotor blades**: The rotor blades extract the wind energy and converts it into rotational form ii) **Gearbox:** It converts the rotational speed from low speed shaft and transforms it into faster rotation on the high speed shaft iii)**Hub:** It is the connection point for the rotor blades and low speed shaft iv) **Mechanical brake**: It is a disc brake used for repairs and maintenance of the wind mill. v**) Generator**: It converts the rotational speed of high speed shaft to electrical energy vi) **Yaw mechanism**. This mechanism keeps the rotor blades parallel to the flow of wind vii) **Anemometer and wind vane**: They are the instruments for measuring wind speed 	**2M** **2M**
	f	A fuel cell is defined as an electromechanical device that continuously converts the chemical energy of fuel into electricity and heat without combustion. The main components of a fuel cell are 1. A fuel electrode (anode) 2. An oxidant electrode (cathode) 3. An electrolyte	**2M**

		4. Additional components are container, separators, sealings, fuel and oxidant supply etc. The porous fuel electrode is anode and other porous oxidant electrode is cathode. These electrodes are separated by a porous gas barrier called separator. The anode is supplied H2 gas as fuel at a certain pressure and the cathode is supplied o2 as oxidant at a pressure. These gases pass through the respective electrodes and bubble around through the electrolyte solution. The pores provide an opportunity to gases, electrodes and electrolyte to come in contact for their electrochemical reactions. The electrodes are connected through an external circuit as shown .  	**2M**
Q.6	a)	**Effect of greenhouse gases on climate change** : The effect of earth's atmosphere due to trapping of long wavelength infrared radiations by the CO_2 layer in the atmosphere is called Green house effect. CO_2 produced by power plants has no ill effect on human life biologically but increased concentration of it may cause the climate change due to its heat trapping quality leading to green house effect. **Global Warming:** It is also affects on climate. It refers to the long term fluctuations in Temperature, precipitation, wind and earth elements of the earth climate system. The effects of global warming have taken its role on people, animals, birds and habitat. In fact no continent has been spared. Developing countries are twice as at risk to climate change as industrialized countries, and small islands states are thrice as at risk. Estimates drawn from reports by the Intergovernmental Panel on Climate Changes (IPCC) projects increase in average global temperatures ranging from 1.4 0C to 5.8 0C	4M
	b)	**Applications of solar energy:** 1. Solar water heating 2. Solar cookers 3. Solar distillation 4. Solar drying 5. Solar green houses 6. Solar power generation 7. Solar photovoltaic cell for electric power generation 8. Solar Furnaces	4M ½ M Each (Any Eight)

		9. Heating and cooling of residual building	
	c)	**Anaerobic digestion:** Anaerobic digestion is a biochemical process in which the particular kinds of bacteria digest biomass in an oxygen free environment. The process of anaerobic digestion occurs in a sequence of stages involving distinct types of bacteria. Hydrolytic and fermentative bacteria first break down the carbohydrates, proteins and fats present in biomass feedstock into fatty acids, carbon dioxide, hydrogen, ammonia and sulfides. This stage is called hydrolysis Next, acetogenic bacteria further digest the products of hydrolysis into acetic acid, hydrogen and carbon dioxide. Methanogenic bacteria then convert these products into biogas. The combustion of digester gas can supply useful energy in the form of hot air, hot water or steam. After filtering and drying, digester gas is suitable as a fuel for an I.C. engine, which combined with generator, can produce electricity. **Factors affecting bio digestion: Following factors are affecting the biodigestion:** 1) pH or the hydrogen-ion concentration 2) temperature 3) total solid content of the feed material 4) loading rate 5) seeding uniform feeding 6) Diameter to depth ratio 7) Carbon to nitrogen ratio 8) Nutrients 9) Retention time 10) Types of feed stock	**2M** **2M**
	d)	**Classify hydroelectric power plant :-** The classification according to Quantity of water available is i) Run-off river plants without pondage ii) Run-off river plants with pondage iii) Reservoir Plants The classification according to availability of water head is i)Low-Head (less than 30 meters) Hydro electric plants ii) Medium-head(30 meters – 300 meters) hydro electric plants iii) High-head hydro electric plants The classification according to nature of load is i) Base load plants ii) Peak load plants	**4M**
	e	**Angstrom Pyrheloimeter**:- This pyrheliometer has a rectangular aperture, two manganin-strip sensors (20.0 mm × 2.0 mm × 0.02 mm) and several diaphragms to let only direct sunlight reach the sensor. The sensor surface is painted optical black and has uniform absorption characteristics for shortwave radiation. A copper-constantan thermocouple is attached to the rear of each sensor strip, and the thermocouple is connected to a galvanometer. The sensor strips also work as electric resistors and generate heat when a current flows across them. When solar	**2M**

		irradiance is measured with this type of pyrheliometer, the small shutter on the front face of the cylinder shields one sensor strip from sunlight, allowing it to reach only the other sensor. A temperature difference is therefore produced between the two sensor strips because one absorbs solar radiation and the other does not, and a thermo electromotive force proportional to this difference induces current flow through the galvanometer. Then, a current is supplied to the cooler sensor strip (the one shaded from solar radiation) until the pointer in the galvanometer indicates zero, at which point the temperature raised by solar radiation is compensated by Joule heat.  	**2M**
	f	**i) List of materials used for bio gas generation** Almost any organic material can be processed with anaerobic digestion. Anaerobic digestion is particularly suited to wet organic material and is commonly used for effluent and sewage treatment. This includes biodegradable waste materials such as waste paper, grass clippings, leftover food, sewage and animal **ii) Main application of biogas:** This energy release allows biogas to be used as a fuel; it can be used for any heating purpose, such as cooking. It can also be used in a gas engine to convert the energy in the gas into electricity and heat. Biogas can be compressed, the same way as natural gas is compressed to CNG, and used to power motor vehicles.	**2M** **2M**